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ASTROMETRIC OBSERVATIONS OF COMETS AND ASTEROIDS
AND SUBSEQUENT ORBITAL INVESTIGATIONS

Grant NGR 09-015-212

Semiannual Progress Report No. 26
For the period 1 May through 31 October 1986

Principal Investigators

Dr. Richard E. McCrosky

Dr. Brian G. Marsden

November 1986

prepared for

National Aeronautics and Space Administration
Washington, D.C.

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this grant is
Dr. Henry C. Brinton, Code EL-4, NASA Headquarters,
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ASTROMETRIC OBSERVATIONS OF COMETS AND ASTEROIDS
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1. Personnel

Observations, data reduction and interpretation of results contributing to this research are performed by Principal Investigator R. E. McCrosky and Co-Investigator B. G. Marsden; and by G. Schwartz, C.-Y. Shao, C. M. Bardwell and D. W. E. Green as members of their research groups. The services of all except Shao and less than 10 percent of Bardwell are provided at no cost to NASA.

2. Observing Program

The 155-cm reflector was used for observations of comets and minor planets on 32 nights during April-October. The distribution was fairly uniform, ranging from 45 in June and September to 28 in July; on September 1 a total of 17 observations was made. Table 1 lists the 230 measurements published (in the MPCs) during the semester. These include six additional measurements going back to 1984 and the republication of a previously misidentified 1976 observation as a new discovery. Thirty-two of the observations refer to comets, 83 to numbered minor planets (numbered, that is, by the end of the semester: only 16 of them refer to minor planets already numbered at the time of the last report), and the remainder (just half the total) to unnumbered minor planets.

The observing and measuring has generally been done by McCrosky, Schwartz and Shao. Most of the checking of the results and the selection of objects to be observed was done by Bardwell, with some assistance from Marsden and Green. The reductions were mainly done on the NOVA computer at the Oak Ridge Observatory, while the remaining computations were done on the VAX computer in Cambridge.

3. Results of Special Interest

Observations were made of all four new comets discovered during the semester (1986d, 1986e, 1986i, 1986l), and there was continuing coverage of three of the new comets of the previous semester as well as of P/Halley.

Among the older-numbered minor planets observed were the earth-approaching objects (3103) 1982 BB, (3199) 1982 RA (Nefertiti), (3361) 1982 HR and (3362) 1984 QA (Khufu), some of which were of interest for radar experiments.

Unnumbered earth-approaching objects observed were 1963 RH, 1983 RD, 1985 TB and 1986 DA, as well as the new discoveries 1986 JK, 1986 LA and 1986 PA.

The following minor planets were numbered entirely as the result of our observations: (3438) 1974 SD5, (3449) 1978 VR9, (3450) 1983 QJ, (3453) 1981 SS5, (3460) 1973 QB2, (3461) 1977 SA1, (3462) 1981 UA10, (3464) 1983 BA, (3467) 1981 SF2, (3472) 1981 EJ10, (3476) 1978 UF2, (3477) 1979 KH, (3483) 1976 YP2, (3484) 1978 NE, (3487) 1978 UF, (3492) 1985 DQ, (3497) 1941 HJ and (3503) 1981 EF17.

4. Orbital Investigations

These have been conducted as usual: preliminary and improved orbits, predictions and linkages of identified minor planets.

5. Publications

Observations from Oak Ridge plates are included in the following publications issued during this half year: Minor Planet Circ. Nos. 10676-10677, 10699, 10794-10795, 10815-10816, 10891, 10893, 10909-10910, 10997-10999, 11015-11016, 11111, 11139-11140, 11209, and 11228-11229; IAU Circ. Nos. 4214, 4241 and 4243. Orbital computations are on Minor Planet Circ. Nos. 10750-10752, 10759-10773, 10816-10833, 10936, 10945-10957, 11035, 11041-11055, 11141-11142, 11148-11155, 11230-11231, 11235-11238 and 11239-11242; IAU Circ. Nos. 4211, 4214-4215, 4217-4218, 4220, 4223, 4228-4229, 4236-4240, 4242-4243, 4250, 4252, 4256 and 4266.

Table 1

Positional measurements

The successive columns give the object's designation (/ = comet, * = new discovery), the UT date and time, the right ascension (in hours, minutes and seconds) and declination (in degrees, minutes and seconds) -- equinox 1950.0.

/1982i	1986 05 11.06822	10 33 33.42	-11 54 35.7
/1982i	1986 06 03.07240	10 24 00.21	-06 18 26.7
/1982i	1986 06 05.07359	10 24 13.42	-06 05 26.0
/1982i	1986 06 09.06878	10 24 56.46	-05 43 55.7
/1982i	1986 06 10.07249	10 25 10.33	-05 39 22.5
/1985m	1986 05 10.30950	19 15 31.82	+13 44 20.9
/1985m	1986 06 04.23808	17 52 50.01	+12 19 13.4
/1985m	1986 06 10.24770	17 32 03.49	+11 18 31.0
/1985m	1986 07 04.14517	16 24 42.92	+05 54 15.4
/1986b	1986 05 10.06166	09 51 07.67	+28 38 02.9
/1986c	1986 05 12.08925	10 55 44.75	-01 37 30.1
/1986d	1986 05 09.19961	14 47 30.17	-05 36 51.4
/1986d	1986 05 10.22230	14 47 02.41	-05 27 25.9
/1986d	1986 06 03.10982	14 40 16.14	-03 00 58.4
/1986d	1986 06 05.17063	14 40 14.46	-02 55 59.3
/1986d	1986 07 08.08697	14 55 38.15	-04 07 05.1
/1986e	1986 05 15.32639	00 20 21.12	+40 20 49.9
/1986e	1986 06 03.27555	20 33 01.06	+43 19 29.1
/1986e	1986 06 04.30915	20 17 07.92	+42 24 29.3
/1986e	1986 06 05.21174	20 03 30.23	+41 28 47.8
/1986e	1986 06 09.25651	19 07 07.43	+36 06 34.7
/1986e	1986 06 10.27270	18 54 32.29	+34 31 38.8
/1986e	1986 07 04.16594	16 33 16.60	+03 27 15.8
/1986e	1986 07 08.14043	16 25 34.45	+00 37 42.2
/1986i	1986 08 04.22419	21 06 48.38	-25 01 17.5
/1986l	1986 08 06.15515	22 20 48.87	+25 06 19.9
/1986l	1986 08 06.28811	22 20 35.12	+25 05 40.3
/1986l	1986 08 09.14296	22 15 34.72	+24 49 13.7
/1986l	1986 08 09.14691	22 15 34.24	+24 49 11.8
/1986l	1986 08 10.20753	22 13 38.96	+24 42 19.1
/1986l	1986 09 01.08859	21 29 04.12	+20 34 28.2
/1986l	1986 09 07.17391	21 15 59.72	+18 49 45.2
579	1986 07 04.08752	11 59 57.93	+10 47 35.9
585	1986 06 05.19154	15 19 39.46	-07 05 38.9
861	1986 07 08.20370	18 49 57.89	-20 20 49.4
938	1986 04 13.25810	13 32 50.71	-05 45 04.0
1197	1986 09 02.26902	22 22 14.69	+08 58 24.2
1309	1986 06 10.17397	14 51 07.27	-09 49 00.8
3103	1986 06 05.30031	20 49 55.50	+10 12 48.1
3103	1986 06 10.28808	20 59 32.28	+10 48 56.7
3103	1986 07 08.30755	22 13 49.34	+10 24 47.6
3103	1986 07 10.32670	22 22 07.28	+09 52 17.2
3199	1986 08 06.30619	00 52 58.01	-23 51 55.2
3199	1986 09 01.28574	23 47 15.36	+08 44 02.3
3361	1986 05 10.28437	16 17 15.88	-06 57 46.8
3362	1986 09 01.36830	01 50 58.38	-01 08 37.4
3416	1986 02 13.40102	12 22 28.00	+22 33 10.7
3416	1986 04 04.18798	11 12 43.03	+22 41 54.2
3439	1984 11 27.29386	04 59 38.00	+29 05 27.6
3439	1986 02 04.32151	10 24 56.81	+14 48 12.6
3439	1986 04 13.14403	09 40 56.93	+16 57 28.5
3442	1986 04 13.16651	10 33 04.72	+24 18 08.1
3444	1986 04 12.24978	11 36 03.77	-01 19 16.3
3446	1986 02 09.42761	13 21 21.61	-00 42 15.6
3446	1986 05 11.13260	12 25 20.32	-00 20 30.5
3447	1986 05 11.11523	11 11 37.02	-06 07 06.7
3448	1986 04 05.33942	14 55 59.10	-15 41 36.4
3448	1986 05 11.20137	14 20 56.94	-13 48 15.3

3449	1986 04 13.30227	13 56 16.29	-09 27 31.1
3449	1986 05 12.21158	13 35 41.46	-07 42 42.9
3450	1986 04 05.29092	13 05 33.57	+01 59 34.1
3450	1986 05 12.16567	12 39 59.05	+03 11 41.8
3451	1986 04 14.34777	18 06 43.33	+03 29 44.6
3452	1986 04 12.28921	13 04 32.51	-04 08 23.4
3452	1986 05 11.15679	12 41 49.01	-02 22 58.3
3468	1986 06 09.08714	11 33 35.17	+15 04 08.0
3470	1986 04 14.27018	12 20 09.71	-05 48 36.4
3470	1986 05 12.12034	12 11 26.59	-03 43 19.6
3472	1985 02 21.26508	09 08 24.80	+09 31 28.4
3473	1986 04 12.33256	15 19 13.13	-16 29 38.8
3473	1986 05 10.24631	14 56 29.07	-14 51 22.6
3473	1986 06 04.11531	14 38 07.83	-13 41 15.2
3473	1986 06 05.14145	14 37 42.17	-13 39 59.6
3476	1986 04 14.28789	12 21 12.15	+18 32 08.1
3476	1986 06 10.09200	12 05 27.55	+12 37 28.5
3477	1986 05 11.29927	15 52 42.82	-10 43 24.1
3477	1986 06 04.15700	15 31 41.05	-08 33 12.7
3481	1986 06 10.17397	14 50 58.12	-09 38 34.2
3483	1986 05 12.29873	16 48 02.16	-02 48 29.4
3483	1986 06 03.18176	16 17 27.71	-06 04 02.6
3484	1986 04 12.35042	16 40 50.49	-00 36 50.6
3484	1986 05 11.31681	16 30 04.98	+01 09 30.3
3484	1986 06 03.15903	16 09 36.94	+00 40 45.2
3485	1986 04 14.25016	11 35 54.34	+00 12 33.3
3487	1986 06 10.31457	21 35 40.35	+03 00 21.7
3487	1986 07 10.31138	21 42 44.66	+05 46 59.4
3490	1986 04 13.21608	10 56 47.91	+04 03 51.6
3490	1986 04 14.23349	10 56 23.85	+04 04 30.8
3492	1986 06 09.30512	21 16 56.12	-08 26 29.8
3492	1986 07 04.28787	21 15 23.90	-09 58 20.5
3493	1985 02 21.05282	04 29 44.03	+18 34 23.3
3493	1986 06 03.22778	16 59 37.41	-14 00 56.2
3493	1986 07 08.15836	16 30 16.62	-15 32 31.8
3494	1986 04 12.30813	14 53 57.11	-19 48 41.2
3494	1986 05 10.20675	14 29 41.88	-16 41 33.9
3495	1986 04 13.32648	15 32 02.02	-15 23 43.5
3495	1986 05 10.26197	15 14 17.86	-14 09 23.4
3496	1986 08 10.33152	01 21 49.12	-23 40 56.2
3497	1986 08 06.26741	22 59 55.54	-03 46 31.6
3497	1986 09 07.23088	22 37 34.77	-08 04 57.7
3498	1986 09 07.27918	23 03 40.99	+04 13 03.1
3499	1986 08 06.22919	22 13 19.30	-10 44 57.2
3499	1986 09 02.21725	21 54 22.04	-12 56 48.2
3500	1986 07 08.32167	23 17 19.21	-04 03 58.9
3500	1986 08 06.28361	23 26 30.65	-00 54 21.4
3500	1986 08 10.31174	23 25 25.35	-00 40 21.9
3502	1986 09 08.29836	23 29 39.31	-07 43 59.5
3503	1986 07 10.13910	18 08 15.46	-01 39 12.5
3503	1986 08 06.06278	17 56 45.89	-04 15 35.4
3503	1986 09 08.04871	18 11 43.21	-08 42 29.8
3504	1986 09 02.18372	21 24 25.83	-16 47 32.5
3505	1986 08 09.31692	23 02 22.01	+02 08 28.1
3505	1986 09 01.20546	22 45 44.33	+01 58 14.2
3506	1986 08 10.23463	21 59 31.16	-17 27 06.8
3506	1986 09 02.20128	21 39 29.42	-17 55 59.5
1941 SW	1986 06 03.32384	20 11 59.18	-07 58 29.7

1941 SW	1986 07	04.26488	20 02	57.24	-06 30	47.5
1941 SW	1986 08	04.20012	19 40	05.86	-07 26	58.1
1955 BG	1986 04	14.36676	16 11	47.95	-09 34	04.6
1955 BG	1986 05	11.26221	15 50	39.21	-09 07	46.9
1963 RH	1986 04	13.03754	08 04	20.60	+07 16	14.8
1964 TN2	1986 08	09.29369	22 51	30.38	+04 48	35.4
1964 TN2	1986 09	01.19156	22 35	58.44	+04 05	14.2
1964 UO	1986 09	08.27689	23 22	45.77	+11 42	19.9
1965 UZ	1986 09	07.25741	22 52	37.51	-05 37	00.5
1976 SE1	1986 09	07.21336	22 34	32.57	-06 03	57.2
1976 YU5	1986 08	05.29262	22 11	29.28	-01 26	38.1
1976 YU5	1986 09	01.15623	21 48	39.31	-02 37	27.6
1976 YW7 *	1976 12	28.25411	06 10	39.67	+21 08	14.0
1977 PE1	1986 07	08.27299	19 40	04.03	-14 41	18.8
1977 QC4	1986 09	01.32442	00 23	10.09	-08 15	35.8
1978 UH2	1986 09	08.25830	23 10	48.63	+14 01	44.1
1979 HF5	1986 06	05.27954	19 50	52.11	-12 18	16.8
1979 HF5	1986 07	10.17645	19 28	23.71	-12 25	52.4
1979 QL8	1986 06	09.28115	19 12	48.35	-20 30	54.2
1979 QL8	1986 07	08.20370	18 50	11.77	-20 14	36.3
1979 QL8	1986 09	02.08010	18 37	02.61	-20 20	12.4
1980 DO5	1986 09	08.23304	23 06	18.01	-09 57	51.3
1980 FB	1986 05	10.18111	12 56	36.01	-05 54	27.0
1980 OE	1986 06	04.09365	14 29	44.56	-16 54	25.5
1980 OE	1986 06	09.15770	14 26	58.72	-16 35	42.0
1981 EW3	1986 09	08.09386	20 42	33.87	-08 00	49.6
1981 ET16	1986 08	10.25394	22 15	40.76	+07 48	42.4
1981 ET16	1986 09	02.24443	21 59	57.27	+03 57	03.7
1981 EN26	1986 05	12.27238	15 38	36.34	-09 06	25.1
1981 EN26	1986 06	05.19154	15 20	33.89	-07 24	57.0
1981 EE27	1986 06	05.25590	18 43	33.74	-03 20	09.6
1981 EE27	1986 07	08.18433	18 16	06.33	-03 21	52.3
1981 EQ27	1986 07	10.27957	20 29	36.18	-15 54	45.3
1981 EQ27	1986 08	05.18332	20 06	10.49	-17 30	12.4
1981 EL19	1986 04	13.25810	13 32	12.25	-05 39	19.6
1981 EL19	1986 05	11.17857	13 12	20.54	-02 55	16.8
1981 EQ19	1986 08	09.20843	21 16	44.25	-11 11	02.4
1981 EQ19	1986 09	02.16705	20 56	50.58	-13 16	50.1
1981 FB	1986 06	04.26855	18 07	24.05	-04 28	24.2
1981 FB	1986 07	04.21611	17 41	43.47	-03 54	58.9
1981 JA	1986 04	14.20789	10 45	14.55	+09 08	20.6
1981 RU2	1986 09	01.30699	23 41	37.69	+12 46	40.7
1981 SQ1	1986 08	05.22234	21 23	57.39	-12 22	51.0
1981 SQ1	1986 09	08.13832	21 01	27.84	-14 48	00.7
1981 SW6	1986 08	05.27728	22 00	07.88	-05 31	50.4
1981 SW6	1986 09	07.18882	21 38	11.75	-08 51	35.2
1981 SW7	1986 08	09.34296	23 10	19.69	+00 10	56.6
1981 SW7	1986 09	01.24751	22 55	43.31	-00 14	19.9
1981 SX7	1986 08	06.19773	21 06	59.08	-10 15	10.7
1981 SX7	1986 09	08.11717	20 46	19.39	-11 45	42.2
1982 BJ	1986 05	12.32321	16 48	49.67	+13 43	21.0
1982 BJ	1986 06	03.20696	16 25	05.56	+12 01	57.0
1982 BQ	1986 06	04.17693	15 36	39.43	-08 26	45.7
1982 BS1	1986 05	10.12696	10 51	10.61	+12 27	44.2
1982 TX	1986 08	04.28050	22 20	36.12	+18 44	12.4
1982 TX	1986 08	10.28984	22 17	35.97	+19 09	57.1
1982 TX	1986 09	01.11013	22 00	55.06	+18 30	27.0
1982 TG1	1986 08	04.33540	22 41	58.68	+10 58	39.1

1982	TG1	1986	09	02.26902	22	22	39.55	+09	04	57.5
1982	UX	1986	06	04.19296	16	22	13.75	-19	50	21.6
1982	UH2	1986	09	01.17191	22	11	12.22	-11	33	32.1
1983	PW	1986	09	08.02337	16	48	45.00	-18	15	36.1
1983	RD	1986	08	04.18074	19	23	06.63	+08	30	23.9
1983	RD	1986	08	09.17767	19	19	40.28	+07	59	56.0
1983	RD	1986	09	01.03052	19	20	04.15	+00	10	27.8
1983	RO2	1986	06	04.21646	17	03	20.10	-15	11	19.8
1983	RO2	1986	07	04.19252	16	35	50.47	-15	24	07.5
1983	SC	1986	05	12.13854	12	37	51.45	-13	10	41.5
1984	AP	1986	08	05.16290	20	00	01.03	-16	55	20.1
1984	AC1	1986	09	08.35865	01	24	01.80	-06	15	43.3
1984	QO	1986	04	13.23862	11	19	58.74	-03	53	23.2
1984	WB	1986	06	05.32113	21	42	35.60	+11	59	51.4
1984	WB	1986	07	08.29142	21	41	16.49	+21	21	03.4
1984	WB	1986	08	05.20920	21	14	29.17	+25	37	24.4
1984	WB	1986	09	03.14496	20	41	32.27	+23	47	18.7
1984	YV	1986	07	04.30723	22	17	09.67	+08	20	22.3
1984	YV	1986	08	04.25931	21	53	18.57	+15	17	35.0
1984	YV	1986	08	10.21965	21	45	33.19	+16	05	41.8
1985	FE	1986	07	10.29359	21	33	43.33	-06	52	41.9
1985	FE	1986	08	04.23789	21	15	35.23	-06	52	29.2
1985	TB	1986	04	13.19392	10	05	40.71	+38	26	23.3
1985	TB	1986	04	14.31513	10	06	50.66	+37	37	22.8
1986	AK	1986	06	04.07419	11	02	34.84	+24	49	04.4
1986	AK	1986	07	04.08752	12	00	55.75	+10	51	22.6
1986	CN	1986	04	13.11217	09	33	25.32	+25	00	43.0
1986	DA	1986	05	10.16588	13	09	40.09	+01	05	18.5
1986	DA	1986	06	03.08565	14	10	35.66	-12	23	58.5
1986	DA	1986	06	09.11099	14	23	37.43	-14	39	18.5
1986	EC2	1986	05	10.14807	11	15	15.61	+02	57	54.8
1986	GA	1986	04	13.30227	13	56	54.61	-09	28	49.7
1986	GN1 *	1986	04	13.30227	13	56	23.30	-09	09	04.1
1986	JK	1986	05	15.23954	15	37	44.56	-16	28	56.9
1986	JK	1986	05	16.25104	15	41	41.78	-16	52	11.6
1986	LA	1986	07	04.11196	14	49	55.37	+16	39	20.2
1986	LA	1986	07	08.11551	14	54	13.72	+18	22	19.7
1986	LA	1986	08	05.10814	15	49	56.85	+27	13	25.1
1986	LA	1986	09	01.07182	17	29	46.19	+31	10	55.1
1986	LR *	1986	06	10.17397	14	51	08.15	-09	36	13.5
1986	NV *	1986	07	08.22817	19	04	36.71	-19	47	11.3
1986	PA	1986	08	10.18648	19	32	48.63	-01	42	24.3
1986	PA	1986	09	02.05451	18	18	30.57	-14	10	26.9
1986	PA1	1986	09	02.09999	20	18	19.57	-19	11	25.9
1986	PA1	1986	09	07.07276	20	16	58.29	-19	20	30.3
1986	PL4 *	1986	08	06.26741	23	00	23.43	-03	52	00.3
1986	RB	1986	10	03.10352	21	55	52.80	+06	39	14.5
1986	RB	1986	10	07.06181	21	52	55.54	+07	27	00.8
1986	RH	1986	10	03.17918	22	41	57.94	-02	44	55.8
1986	RH	1986	10	06.08511	22	40	45.14	-02	53	59.2
1986	RZ *	1986	09	01.13291	21	52	56.89	-01	34	37.2
1986	RA1 *	1986	09	01.17191	22	11	12.47	-11	36	10.1
1986	RB1 *	1986	09	01.32442	00	23	06.87	-07	57	03.9
1986	RC1 *	1986	09	01.34684	00	37	11.55	+03	34	23.6
1986	RC2	1986	10	03.09251	22	04	19.27	+00	11	18.1
1986	RC2	1986	10	07.15899	22	05	01.00	-01	45	30.2